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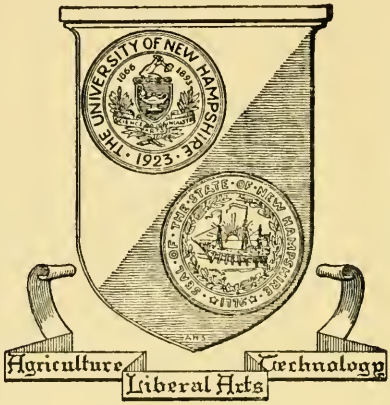
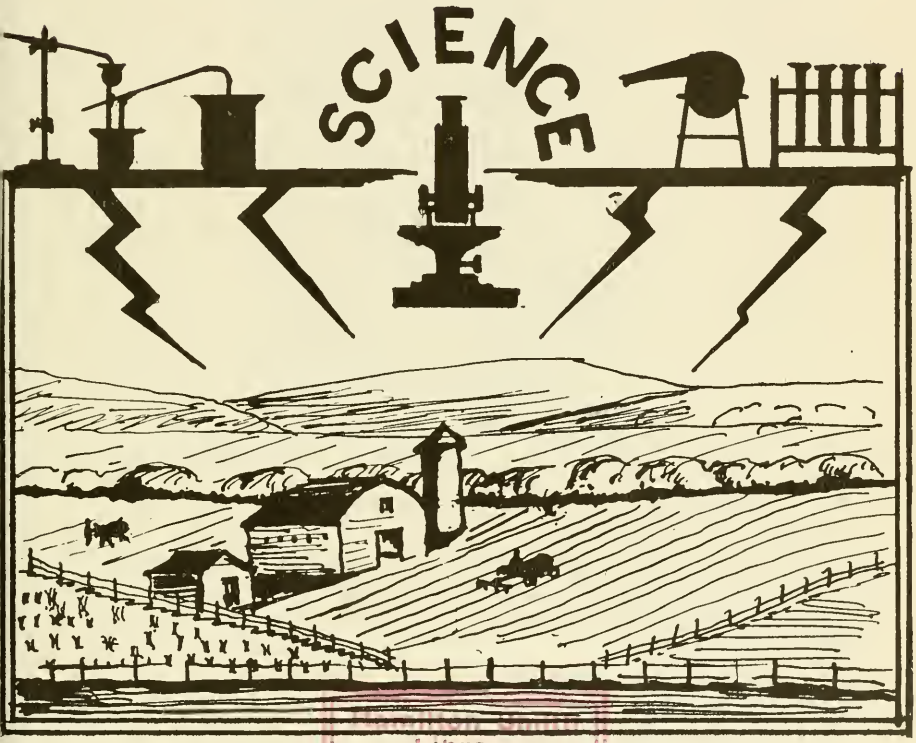


The University
of
New Hampshire

Bulletin 330 May, 1941

AGRICULTURAL RESEARCH IN NEW HAMPSHIRE



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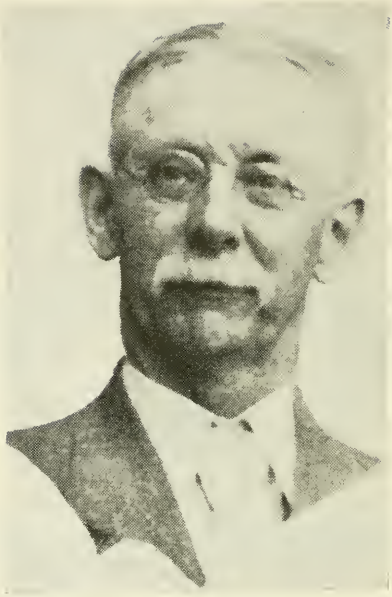
ANNUAL REPORT OF THE DIRECTOR OF THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION FOR 1940

Durham, N. H.



ORMOND ROURKE BUTLER (1877-1940)

Professor of Botany and head of the Botany department since 1912, died October 24, 1940. For a description of his work and publications, see page 12

THE AGRICULTURAL EXPERIMENT STATION
in
NEW HAMPSHIRE

Annual Report of Director M. Gale Eastman for the Year 1940

THE foundation of progressive agriculture is not likely to be divorced from research. America had a great educational idea when it evolved a plan which should make classroom training available to those who labored and lived on the land. Evidence of such thinking was emphasized by the Congress when it passed the Land-Grant College act in 1862. The act was the product of an attitude that farmers were worth educating, or that a man whose business was to be farming had need of some mental training that could be promoted in the classroom. This well-conceived child of education came near being still-born, and then struggled weakly for lack of proper nourishment during at least twenty-five years of infancy and adolescence. It gained strength and ability only after research came to the rescue in providing proper sustenance. For such further help the people were again indebted to the Congress and its vote of 1887 which established the Hatch act, giving each state $15,000 for research in agriculture. Soon, some facts had been carefully gathered, tabulated, and described. Teachers had something to teach; education discovered its base; a foundation had been provided on which to build agricultural science.

Down through the ages, since evolution through chance or direction had sufficiently differentiated one animal from another so that man had somewhere, somehow made himself known, there was doubtless an ebb and flow of food and famine,—sometimes an improvement as a result of man's new techniques, and just as often a reversal due to the vicissitudes of nature. Man became proficient early in subduing or eluding his enemies. He found or fashioned other shelter as soon as he could exist without the protection of a cave. Thereupon he could hunt for animals, roots, and natural fruits more widely. He domesticated animals to his use and found pasture for their sustenance. Much later he corralled his animals, housed them against inclement weather, planted crops, and did less wandering. Then, he had the experience of learning that other animals, as well as man, competed with him for food and that he must relinquish his appetite for animal flesh and animal products in favor of nourishing his family with vegetation. He was often, indeed usually, hungry; too hungry to thrive. The competition was keen. Humanity's upward climb for prestige in numbers within the clan or the kingdom or the region was slow and uncertain. Disaster stalked ever at his elbow in devastating, unpredictable diseases often born in weakness of body resulting from too many mouths to feed from poor harvests.

Within the span of history, man's only source of increasing food supplies seemed to lie in discovery of new countries and colonization.

With the occupation of America and the circumnavigation of the globe, land resources were definitely at an end. The civilization of the early 19th century had expressed the hopelessness of the situation through Thomas Robert Malthus. Much of the unhappiness, squalor, and degradation among humanity was inevitable so long as nothing was done to curtail population. Mankind could in no way hope to continue to find new lands for the use of the ever-increasing millions of consumers. All the world had now been discovered. Only by a reduction in the birth rate could any improvement for humanity as a whole be expected.

Nevertheless, history indicates that the population of the world, slowly but relentlessly occupying and filling every new country to the apparent limit of food production and hovering around the threat of starvation, suddenly accelerated its increase in the 19th century, following Malthus' dire prognostication, so that the world harbored twice as many human beings in 1900 as it had in 1800. It is for us to wonder why or to explain! How could twice as many people, an additional world, be fed in 1900, and be better fed than in 1800?

The answer may well be that America has not been willing nor content to accept the dictum of Malthus. First, she tried education; then she discovered its weakness, and added research; then she added more research. Out of it all we learned that prairies could be used for other crops than grass, that they were as easy to plow as appearances indicated, and that the soil was fertile, even that the climate of our Middle West was propitious. We soon had proof that the use of an iron plow would not poison the land! Better adapted crops, more efficient animals, new knowledge of feeding both crops and animals developed. All in all, American ingenuity had combined mechanical and biological science to make possible greater production from far fewer farmers.

Previous to the outbreak of the World War, the scarcely four per cent of the world's farmers located in the United States had come to produce more corn, cotton, tobacco, and hogs than all the rest of the world. They produced one-fourth of all the cereals. They were exporting agricultural products for the use of other countries in larger quantity than all the rest of the world added together. Along with the war came the patriotic appeal for more production. "Food will win the war." Production as a whole was slightly increased, but most of the change came through shifting crops to correspond to anticipated war needs. Wheat production, for example, was greatly expanded. Measures of the physical volume of production of food and feed crops indicate that maximum production per capita in the United States occurred in 1915, the first season after the war started and two years before we entered the conflict. The next highest production was in 1912, before the war was anticipated, and the third highest was in 1920, two years after the armistice was signed. Since 1920, it has always been less than in any one of these three years. The average for the crop years 1911-14, pre-war, was more than for the years 1916-1919.

During and as a result of the war, a real discrepancy was developed in buying power. Previous to the war, we had been developing a new country, borrowing money in Europe to finance the extension of railroads and other accessories until our enormous annual interest payments made a good excuse for supplying some of Europe's food needs to gain back some part of the credits we needed. But after the war was over, Europe owed us five times as much as we had ever owed her. European countries could not hope to pay cash, and we wished neither their goods nor the assumption of any more of their debts. Thus, we lost our foreign market.

For the first time in the world's history, the United States was endowed with an apparent over-supply of farm products. There were other contributing causes within our own boundaries. A greatly reduced horse population meant a corresponding decrease in demand for farm production, and, later, curtailed buying power was evident among the great majority of our consuming public which had been released from food production to live elsewhere than on farms. Other changes resulted from the war, or were concurrent as a matter of chance. In either case, many reacted on post-war adjustments in agriculture. Under the stress of war, we put 10,000,000 acres of new land into wheat and at practically the same time completed the conquest of still more agricultural land. Just previous to the war we reached the peak of migration from country to city, a half-million persons a year, which had to be fully reversed some twenty years after the war. The census year in which we had more urban than rural population for the first time had been passed. Industry and commerce had advanced to a position of dominance. A lessening of the birth rate had become noticeable and prognostications were rife with the idea of an early stationary population to be almost immediately superseded by a decline. The accuracy of this last prophesy has since become increasingly obvious.

From the standpoint of research work in agriculture, all this has a relationship. For the first quarter of a century following the Hatch act of 1887, agricultural research contributed to science for teaching and for production. The two together met the challenge of the world's greatest need in a significant way by feeding twice as many people and probably about twice as well. Then came the World war and its aftermath, in which farmers have been subject to criticism for producing too much and for not properly adjusting crops to consumption needs. Nevertheless, every large city has perpetuated its slums, where lack of proper food is scarcely less apparent than lack of clothing and shelter; and certainly foreign regions of concentrated populations, like China and India, have never been over-supplied. Because farmers had solved one part of the problem, there is little justification to blame them for all the other parts that still remain unsolved.

Agricultural research funds have been directed into quite different channels since the war, embracing more of marketing, human relations, utilization of by-products, surpluses, and conservation of

fast-vanishing natural resources in soils and vegetation. Recently directors have recognized and considered criticism to the effect that not enough funds have been allocated to marketing research. There have been some legitimate explanations, following honest efforts to accomplish more in this line. Marketing of agricultural products is often an involved and complicated problem. It does not end within the farmer's jurisdiction. Doubtless some matters to be corrected may be beyond the province of the farmer. It is easy to recognize and prove that inefficient marketing is practiced when several milk wagons peddle milk at the same apartment house every morning in the year. It is quite another matter to correct. Present indications are that the solution of such an apparently simple condition may have to await the naming of milk as a public utility. Again, the public is likely to overlook an enormous amount of the research work aimed toward better marketing because it is not labelled "marketing." For example, there is the matter of quality: color of apples, proper storage of fruit, flavor of practically every edible farm product, sprays to keep fruit on the tree for adequate maturity, feeding of hens to improve the appearance of egg yolks as well as the flavor, equipment and practices that insure desirable color and flavor in the production of maple syrup. These are definitely marketing research problems from the standpoint of every director. They are organized and developed specifically for that purpose. During recent years, generous funds have been allocated to just such lines of research.

Again, we must not lose sight of the fact that there are continuous production problems to be checked and watched. The fertilizer industry has been revolutionized in the past generation. Without research, permanent injury from these new products might result from toxic accumulations in the soil that for a time would go unnoticed. New diseases or insects, at least in the sense of new distributions or new environmental factors, could wipe out all possibilities of growing a crop. Examples of significance are the European corn borer, the gypsy moth, and chestnut blight. In fact, with all our vigilance and ability, the chestnut has not been saved, even though some success is now evident in replacing it by means of imported rootstocks.

For the second time, the world is involved in mortal conflict. Again we sow the seeds of a great economic depression. Such far-reaching disturbances must entail price changes, labor problems, and competition for services everywhere. In the unavoidable aftermath, agriculture is certain to suffer disproportionally, particularly in any price-level adjustment—and all because of definite characteristics associated with the fact of its being inherently and inescapably a primary and genetic enterprise. That directors of agricultural research may immediately be called upon to revise projects in favor of preparedness investigations incident to war needs is not foreign to our thinking, nor is there opposition, nor even hesitation, to such a program if it lies in the path of greatest service to the farmers. We appreciate that there is no end of fundamental research in agriculture that shall accrue to the world's advantage, and that no small amount

of thought and study needs to be given by our experiment stations to the problems that must present themselves following the war. Not only thought will be needed, but money must be conserved to that end.

New Hampshire will never be called upon in any emergency or otherwise to contribute enormous agricultural supplies for any purpose. Products on a large scale may be expected from parts of our country that are better endowed with respect to the natural resources of topography, climate, and soil. Recognizing our relationships to production problems as a whole, however, and the proper niche into which our half-million population should be fitted in the distribution and production processes, New Hampshire people may well exercise some ingenuity in taking thought for their own welfare and needs.

Nor is this a selfish or unpatriotic suggestion, for the animals and crops with which we carry on and for which we seek more knowledge and skill in their manipulation are not peculiar to New Hampshire. Any farm problem, recognized and solved in our state, will find its counterpart elsewhere. Any disease for which we can find a cure through research, or any better plant that we may develop through breeding and selection, can hardly fail to be significant in the world's economy. Research that serves us well in New Hampshire must also serve humanity as a whole. At the same time it may render us much less dependent in any emergency on supplies and transportation from other parts of the country.

Station Personnel

Alan G. MacLeod was released as Assistant to the Director to become secretary of the New England Research council June 30, 1940. For some weeks, he had cooperated with that organization and worked part-time for us. Arval Erikson came to us from graduate work at Iowa to supersede Mr. MacLeod as of June 5, 1940. John W. Spaven, Editorial Assistant, was released March 7 to accept a position at Massachusetts State college, and was replaced by John T. Kangas as of March 1.

Robert B. True, Assistant to the Treasurer in the business office, resigned April 10, and Howard W. Feindel took his place.

The main university library lost the services of Mr. Marvin Miller as librarian June 30. He was replaced by David Jolly as of September 1. Miss Doris Dart served as acting librarian in the interim. Robert B. Sears became assistant in charge of the Biological Institute library in Nesmith hall January 1, 1941, following the resignation of Miss Josephine L. Taub, which was accepted as of December 3.

In Agricultural Economics, Harold C. Grinnell was given a leave of absence which became effective October 22. He will return early in June, 1941. Arval Erikson, previously mentioned, became Assistant Economist in Marketing, assuming some of the duties relinquished by Mr. MacLeod. Byron Peterson, a graduate assistant, was released

December 31 to accept a position in the marketing service at Columbus, Ohio.

In Animal Husbandry, Roger M. Doe's assistantship was allowed to terminate in June without replacement.

Due to the death of Dr. O. R. Butler on October 24, 1940, a vacancy resulted in Botany which has not been filled during the calendar year. Harry West and Arthur Howe replaced Kenneth Nolan and Kenneth Anderson respectively as graduate assistants in Botany and Bacteriology.

A graduate assistant has been assigned for the year to the Dairy Husbandry Department in the person of Archie E. Follette.

In Horticulture, C. Lyman Calahan was appointed graduate assistant February 1 to replace E. G. Fisher, who had resigned previously to take a position with the Bureau of Plant Industry at Gainsville, Florida.

C. A. Bottorff resigned as Poultry Pathologist March 31 to go with the Lederle laboratories. M. S. Cover, Assistant Pathologist, resigned January 31 to take a position with the State College in Texas. He was replaced March 25 by James H. Gillespie, who also resigned September 30 to join the army. Roslyn C. Durgin resigned as Research Assistant and R. O. P. Supervisor December 31 to carry on his own private poultry business. Albert E. Tepper is on leave of absence to complete his doctorate at Maryland State university. The following new men are now employed in the Poultry department: Dr. E. F. Waller, from Iowa, as Poultry Pathologist, appointed December 23; Fred E. Allen, from Ohio, as Assistant Poultry Pathologist, appointed November 1; Robert S. Halpin, from Iowa, as Research Assistant and R. O. P. Supervisor, appointed at the end of the year to assume his new duties January 1, 1941.

PUBLICATIONS AND EDITORIAL SERVICE

	No. Pages	No. Copies
Station Bulletin 315 Feeding stuffs report 1939	106	2,500
Station Bulletin 316 Results of Seed Tests 1939	36	2,500
Station Bulletin 317 Inspection of Commercial Fertilizers 1939	11	2,500
Station Bulletin 318 The Marketing of Farm Woodland Products in Carroll County	31	4,000
Station Bulletin 319 Station Report 1939	46	2,500
Station Bulletin 320 Pasture Top-Dressing In New Hampshire	24	5,000
Station Bulletin 321 Markets for New Hampshire Berries	52	3,000
Station Bulletin 322 Farm Organization and Management	40	3,000
Station Bulletin 323 Studies in Economics of Orchard Management III.	23	3,000
Station Bulletin 324 Potato Experiments	38	3,000
Station Bulletin 325 Transportation of New Hampshire Milk II.	23	3,000
Station Bulletin 326 Studies of Pasture Management	24	3,000
Technical Bulletin 74 Penetration of Certain Liquids through the Pronotum of the American Roach	16	2,000
Scientific Contribution 73 Convenient Seedling Support for Growing Plants	2	300
Scientific Contribution 74 Studies on Streptococci of Bovine Mastitis	7	300
Scientific Contribution 75 Variation in Cooking quality of Potatoes as Influenced by Fertilizer	7	300
Scientific Contribution 76 Tree Girth and Yield as Indicators of Subsequent Apple Tree Productivity	5	300
Scientific Contribution 77 Frost Rings in Fall Fertilized McIntosh Apple Trees	4	300
Scientific Contribution 78 Preservation of Soil Profiles by Voight's Method	5	300
	500	40,800

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HARRY WEST, *B.S., Graduate Assistant in Botany*
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FRED E. ALLEN, *D.V.M., Assistant Poultry Pathologist*
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FINANCIAL STATEMENT

Expenditures of the New Hampshire Agricultural Experimental Station
for the year ending June 30, 1940

	Federal funds						
	Hatch	Adams	Purnell	Bankhead-Jones	Bankhead-Jones-Offset	Supplementary*	Total
Expenditures							
Personal services	9,337.11	13,899.86	52,523.91	6,930.61	6,337.07	,19,684.34	108,712.90
Supplies and materials	1,338.77	632.93	2,388.95	253.03	719.63	4,656.46	9,989.77
Communication services	254.36	14.17	116.11	52.21	32.69	305.93	775.47
Travel expense	498.12	58.25	2,120.85	199.32	344.93	1,227.02	4,448.49
Transportation of things	323.54	16.97	53.21	29.97	17.45	51.14	492.28
Publications	579.67	0	1,020.08	144.67	12.57	299.56	2,056.55
Heat, light, water and power	700.00	0	28.25	0	0	52.69	780.94
Contingent	0	0	8.73	0	0	0.	8.73
Equipment	1,968.43	347.82	1,181.59	747.39	892.86	5,403.48	10,541.57
Buildings and land	0	30.00	558.32	0	0	110.00	698.32
Total expenditures	$15,000.00	$15,000.00	$60,,000.00	$8,357.20	$8,357.20	$31,790.62	$138,505.02

*This fund includes expenditures from Sales and Miscellaneous Income.

ORMOND ROURKE BUTLER

Ormond Rourke Butler, head of the Department of Botany of the University of New Hampshire, and Botanist of the New Hampshire Agricultural Experiment Station, died October 24, 1940.

Dr. Butler was a native of Australia. He was born in Melbourne August 14, 1877, the son of Thomas and Mary Anne (Rourke) Butler. When he was eighteen years old he became a resident of the United States and he was granted citizenship fourteen years later. During the last twenty-eight years of his life he was a resident of Durham, New Hampshire.

Dr. Butler received the Diploma of the Institute Nationale Agricole, Lausanne, in 1895. He was viticulturist-horticulturist in California from 1895 to 1900. Pursuing collegiate training he entered the University of California, which granted him a degree of Bachelor of Science and following this a degree of Master of Science in 1905.

He was assistant in viticulture in 1904-05 and became assistant at the Whittier Biological Laboratory in 1906, continuing this work through 1908. Further graduate work was pursued at Cornell University which conferred on him the degree of Doctor of Philosophy in 1910. Dr. Butler then accepted a position as research instructor in the Department of Horticulture, at the University of Wisconsin. In 1912 he was appointed head of the Department of Botany of the University of New Hampshire, and Botanist of the New Hampshire Agricultural Experiment Station. Both of these positions he held until his death.

Dr. Butler was a member of the American Phytopathological Society, a member of the Society of Agronomy, a Fellow of the American Association for the Advancement of Science, and a member of the honorary societies Sigma Xi and Phi Kappa Phi.

In his chosen field Dr. Butler was one of the world authorities on copper compounds in relation to control of fungous diseases. His published papers on copper fungicides are widely known throughout the world and are classics. Because of the relation of copper sprays to certain plant diseases, Dr. Butler gave special attention to the control of apple diseases and the relation of control measures to the production of fruit; and to the control of potato diseases. He was the moving spirit in building up the growing of seed potatoes in New Hampshire and in the present advanced practice of potato seed certification.

Throughout his career Dr. Butler was indefatigable in his work as a scientist. The standards that he set for himself were invariably the highest. In his search for the hidden facts underlying scientific phenomena he never permitted favor or prejudice to influence his findings. He was thoroughly grounded both in his possession of fundamental scientific knowledge and in the planning of his research undertakings. Scientific data secured through his investigations were never in doubt as to their authenticity.

At the time of his death Dr. Butler was engaged in several research projects, one of which, "Control of Apple Scab," is now being prepared for publication. Other investigations included effect of temperature and other environmental factors on symptoms of potato mosaic; spray injury by lime sulphur; effect of temperature on storage of potatoes; control of bitter pit of apple; peony diseases; and control of poison ivy.

Dr. Butler's published works comprise many technical papers, including significant contributions to the series of technical bulletins of the University of New Hampshire and many other scientific papers.

A list of his published works follows:

Technical Bulletin

8—Bordeaux Mixture, 1914. O. Butler.

13—Physiology of the Apple, 1917. O. Butler, T. O. Smith, B. C. Curry.

21—Bordeaux Mixture. II. Stimulatory Action, June, 1922. O. Butler.

22—Experiments on the Field Control of Snapdragon Rust Together With a Description of a Method for the Control of the Disease in Greenhouses, May, 1923. O. Butler.

36—Spray Solutions and the Control of Apple Scab, June, 1928. O. Butler and W. L. Doran.

56—Burgundy Mixture, September, 1933. O. Butler.

Scientific Contribution

9—Methods of Preparation and Relative Value of Bordeaux Mixtures, 1915. O. Butler.

10—The Cuprammonium Washes, 1917. O. Butler.

12—The Effect of the Environment on the Loss of Weight and Germination of Seed Potatoes During Storage, 1918. O. Butler.

14—Relative Adhesiveness of the Copper Fungicides, 1919. O. Butler and T. O. Smith.

15—Effect of Wounds on Loss of Weight of Potatoes, October, 1919. O. Butler.

16—On the Amount of Copper Required for the Control of Phytophthora Infestans on Potatoes, June, 1920. O. Butler.

18—Relation of Potassium to Growth of Plants, April 1921. O. Butler and T. O. Smith.

20—On the Use of the Acetates of Copper as Fungicides, January 1922. O. Butler and T. O. Smith.

22—Spraying for Late Blight of Potatoes, April 1920. O. Butler.

24—Effect of Size of Seed Used in Commercial Planting on the Incidence of Leaf-Roll and Mosaic in Potatoes, June 1929. O. Butler.

25—Experiments on the Control of Mustard, R. Bissey and O. Butler.

27—Effect on Plants of Cyanide Fumigation Following Spraying with Bordeaux Mixture, May 1930. O. Butler and R. R. Jenkins.

38—Effect of Nitrate of Potash on the Vigor and Productivity of Healthy and Leaf-Roll Green Mountain Potato Plants and Their Progenies, November 1932. O. Butler and H. L. Murray.

39—The Use of Kainite for the Control of Poison Ivy, December 1932. O. Butler.

41—Effect on the Growth of Oats of Copper Sprays Used for the Control of Mustard, August 1934. O. Butler and R. Bissey.

45—Effect of Applications of Sodium Chlorate and Ammonium Thiocyanate on Subsequent Sowings of Wheat, October 1934. R. Bissey and O. Butler.

49—Variations in Yield of Pure Line Green Mountain Potatoes Grown in a Controlled Environment, September 1936. O. Butler.

Station Circular

20—Storage of Potatoes, June 1919. O. Butler.

24—Effect of Spray Pressure and Number of Nozzles on Late Blight of Potatoes, March 1925. O. Butler.

25—Control of Apple Scab, April 1925. O. Butler.

45—How Often Should the Potato Grower Renew His Stock? March 1934. O. Butler.

49—Preparation of Bordeaux Mixture with Special Reference to the Use of Commercial Hydrated Lime, May 1936. O. Butler.

REPORTS OF PROJECT LEADERS ON RESEARCH WORK FOR THE YEAR 1940

AGRICULTURAL CHEMISTRY

The agricultural chemistry department for several years has cooperated extensively with other departments which have needed assistance in chemical analysis. This has permitted a fuller utilization of both personnel and equipment in the chemistry department and has made it unnecessary to duplicate either in carrying on various projects in other departments.

During 1940, the agricultural chemistry department has assisted the agronomy department with 5 projects; the horticulture department with three projects; the dairy husbandry department with one project; the entomology department with one project; and the poultry husbandry department with one project. Abstracts of these projects are included with the reports of the cooperating departments.

The Chemical Composition of Timothy (T. G. Phillips and T. O. Smith)

A series of samples, simulating grazing, was taken in 1939, and determination of the soluble carbohydrates is nearly completed. The difficult analytical problems involved in the determination of the solube carbohydrates are being studied. Dr. Kazimierz Strzemienski, employed in August to assist with this work, is making valuable contributions to this phase of the study.

A brief paper is being printed describing the method developed under this project for the determination of small amounts of reducing sugars. It will appear in the Journal of the Association of Official Agricultural Chemists.

(*Adams Fund*)

Inspection of Feeding Stuffs and Fertilizers (T. O. Smith and H. A. Davis)

In the enforcement of the law regulating the sale of concentrated commercial feeding stuffs, 485 brands of these products were analyzed for the state Department of Agriculture, the analyses requiring approximately 3760 individual determinations.

One hundred nine brands of commercial fertilizers were also

analyzed for the state Department of Agriculture. These analyses required about 790 determinations.

(*Miscellaneous Income*)

Chemical Analyses for Residents of the State (G. P. Percival)

The testing of soils for the residents of the state has been continued. During the past year 1535 samples of soil have been received and tested.

Ninety-four samples of feeding stuffs, fertilizers, and other miscellaneous materials have been analyzed for residents of the state. In the testing of the samples, approximately 300 individual determinations were made. There has also been a considerable volume of correspondence relating to inquiries not involving analyses.

(*Miscellaneous Income*)

AGRICULTURAL ECONOMICS

A Detailed Study of Type of Farming Areas in New Hampshire (H. C. Woodworth and John C. Holmes)

The field work in the type of farming project has been completed and a preliminary map indicating classification of land areas by priorities of opportunities in commercial dairy farming has been drawn. Opportunities in other enterprises except as they may influence dairying were ignored in the classification. In the first three areas the opportunities are sufficiently attractive that commercial dairying is expected to continue. The possibilities for commercial dairying in the fourth class area are described as marginal. The operators are handicapped by lack of markets or unproductive farms, but the farms may or may not be continued as dairy farms depending on prices and other alternatives. Because of handicaps in dairying it is expected that most of the commercial dairy farms will eventually be abandoned.

In four counties, Belknap, Cheshire, Merrimack, and Sullivan, cows were reported for 2195 farms. Of this number, 1223 were in good opportunity areas, 454 were in the marginal areas, and 518 were in the areas representing poor opportunities for dairying. Only a few of the herds in the poor opportunity areas would be considered of commercial size, the average herd consisting of only 5.1 cows. In the good areas the average herd was 10.8 cows, and in the marginal areas, 6.9 cows.

In every county the most frequent number of cows reported was one per farm, and the second most frequent number was two. There were 657 herds of 10 cows or more in the four counties. In the state as a whole, there were 2332 herds of 10 cows or more.

(*Purnell Fund*)

A Study of Land Utilization in Grafton County (H. C. Woodworth)

The land utilization project has been continued in order to observe changes taking place in the southern Grafton county area. Data on timber cut were obtained and observations noted as to trend in valuation.

It was intended to carry this project until 1943 and then describe the trend in the 10-year period. Since the hurricane severely damaged the woodlands of the area, it is now planned to complete the field work this summer and discontinue the project.

(*Purnell Fund*)

Spray Management (H. C. Woodworth)

The effectiveness of spraying depends on the timeliness of application, and thus the importance of labor efficiency in covering the orchard rapidly is obvious. The amount of labor used during the past season in spraying the various apple orchards varied from .4 to 1.2 hours per mature tree, indicating little uniformity in spraying practices. There was a great variation in the number of sprays applied, the amount of labor used for each application, and the number of gallons applied at each spraying. As all the orchardists used the calyx spray, the time involved in spraying gives a good index of the relative efficiency in the use of labor.

The calyx spray records over a period of five years on 43 farms totaling 162 orchard years show a wide range in the labor used. In 11 of the 162 records, less than .04 man hours per mature tree equivalent were required, whereas in one, .49 hours were usd. In 100 of the total 162 orchard year records, the labor used fell between .061 and .160 man hours per mature tree. This is only one of the indications of variations in management practices. A wide range in the amount of spray applied also exists. The most frequent quantity of spray reported for a season was three to four gallons per mature tree, yet some farmers applied as much as 12 gallons per tree. These data indicate that the practice of spraying has not been standardized and that great variations exist on the different farms.

(*Purnell Fund*)

Credit Problems in Wholesale Milk Areas (Byron Peterson)

This project, initiated in July, 1940, is confined to the situation of dairymen in the wholesale milk areas on the Connecticut river valley. Confidential financial information was obtained from 100 dairymen, and the analysis is now under way.

The preliminary investigation of the data showed that 22 per cent of the dairymen were free of debt; 30 per cent had debts less than 20 per cent of the total assets; 31 per cent had liabilities between 20 and 40 per cent of total assets; 12 per cent had liabilities between 40 and 60 per cent of total assets; and 5 per cent had debts which exceeded 80 per cent of total assets.

Approximately 76 per cent of the total indebtedness of $192,849 of the 100 dairymen was in the form of mortgage loans.

Type of Indebtedness	Amount	Per Cent
Mortgage	$146,680	76.1
Intermediate	19,091	9.9
Short term	12,972	6.7
Merchant	9,747	5.1
Installment	3,184	1.6
Taxes unpaid	1,175	.6
Total indebtedness	$192,849	100.0

This total indebtedness, as reported by the 100 commercial dairymen, represented 21 per cent of the total assets.

(*Purnell Fund*)

Rural Tax Studies in New Hampshire (H. C. Grinnell)

This project is nearing completion and is about ready for publication. There are two general phases of the work. The first is concerned with a description of the system of local government—how it works. Here the emphasis is placed on organization, administration, and finance of local units, including the county, town, and school and village districts. Functional administration is investigated with respect to fiscal practices, highways, public schools, welfare, and public health.

The second phase is concerned with town taxes as levied in the town for all units of government. For this purpose local fiscal matters have been analyzed for 89 rural towns, and the revenue and expenditure items adjusted to a comparable basis. The purpose of the analysis is to show by tabulations the relation of selected factors to variations in the amount and distribution of expenditures.

Two station bulletins on this project will be available about the middle of the year.

(*Purnell Fund*)

The Place of Woodlots in Farm Organization in Coos County, New Hampshire (John M. Chandler)

In February, 1940, a study in the Colebrook area of Coos County was undertaken in cooperation with the Bureau of Agricultural Economics. Records of farm organization, resources, and income from sale of forest products were taken on a number of farms. The field work and analysis have been completed and a preliminary report prepared, pointing out some ways of increasing farm incomes, with particular emphasis on the possible contribution of the forest resources.

In the past, apparently little attention has been given to making farms more nearly economic units by acquisition of woodland. As a consequence, certain technological developments during recent years have left many local farm people with no outlet for their labor during the winter months. The ownership pattern indicates there is woodland in small lots scattered throughout the area, owned by persons not connected with agriculture. It would appear that over a period of years farmers needing more woodland might be able to purchase enough to meet their individual needs and would do well to consider acquiring this amount to increase farm income. To accomplish the desired results, some sort of long term credit for forestry would be helpful. Approximately 12.5 per cent of the farms in the area fall within this group.

Nine per cent of the farms have sufficient acreage but little or no material ready for cutting at the present time and are not likely to have any in the near future. In such instances they might look to the resources of others for employment until such time as their own growing stocks have been built up. The forest products marketing

cooperative, an organization serving the farmers of the region, could be of assistance in securing employment for these people by changing its policy. By purchasing stumpage and contracting with members to do logging, and by furnishing supervision where non-farmers wish to manage their holdings, it could aid materially in relating this group to near-by resources.

Still a third group are those with sufficient acreage and merchantable timber to utilize all available labor during slack periods, provided a program of forest management is adopted. In most cases it would be to the interest of these people to alter their cutting policy, limiting the cut in any one year to that amount which could be handled by the regular farm labor.

It is estimated that by reasonable management of their forest resources, farmers could increase production by about three times the present level. Returns from sale of these products would be largely reflected in the net farm income, provided the work was done with farm labor.

(*Purnell Fund and B. A. E.*)

Pasture Improvement Studies (M. F. Abell)

Results of studies on brush removal methods and costs of improvement were reported in Station Bulletin No. 326.

Further results are being studied, particularly on the succession of plants under various systems of fertilization. Brush cutting with a power mower was tried on four farms with varying brush conditions to determine labor required, kinds and size of brush capable of removal by power, effectiveness of control of brush growth and reproduction by this means, and methods that must be followed in removal of regrowth in following years. With only slight variation, a power mower with a four and a half foot cut would cut over about an acre in two hours. The brush was gathered together with a horse rake and burned when dry. Burning required about two hours additional time per acre.

Brush up to an inch in diameter was easily handled. Clumps of high bush blueberries were most difficult but could usually be cut on the second attack. Larger brush or trees were removed by hand with an axe or pruning shears. Further work will be done on all plots again this year, both with brush removal and fertilization.

(*Purnell Fund*)

Economies in Purchases Made by Farmers (L. A. Dougherty)

Feed dealers vary greatly in their policies and in the carrying out of their policies in relation to discounts for cash, for farmer delivery, and for volume purchases. In many cases, no discount is given for cash, although sizeable volume discounts may be tied in with cash or short-term credit. There is every indication that small groups of farmers within a neighborhood can make substantial savings in feed purchases by cooperating with the dealer in (1) ordering cars in advance, (2) paying cash on delivery, (3) taking full truck loads or a number of tons in one order.

Fertilizer companies have worked out a scale of charges which gives consideration to the amount of various services offered, such as credit, delivery, and quantity taken.

A collection of data from thirty coal dealers in different localities revealed that 60 per cent of the dealers offered cash discounts of about $1 per ton; 16 per cent a discount less than $1 per ton; and 24 per cent no cash discount. Yard discounts were given by 78 per cent of the dealers, 39 per cent giving yard discounts of $1 or more per ton.

Savings of 20 to 50 per cent over the quart retail price are possible in purchasing oil in cases or 5-gallon quantities. Considerable savings are also possible in buying gasoline in large quantities.

(*Purnell Fund*)

Marketing McIntosh Apples (L. A. Dougherty)

McIntosh apples were available in more New Hampshire retail stores during November and December, 1940, than any other variety. It was found, however, that the apples had often been roughly handled and did not look attractive in the store show cases. Because McIntosh apples are easily bruised and cut, special care should be taken with them. Much education appears to be necessary if the apples are to be handled properly during the storage and marketing process.

Slightly over one-half the deliveries of McIntosh apples in December came from cold storage. A larger percentage of McIntosh apples moved from New Hampshire growers to local markets in November and December than usual. This is partly the result of high production in 1940, and in part because chain stores are taking more McIntosh apples direct from responsible growers.

Buying and selling prices for 53 lots of McIntosh apples in Manchester were obtained in the period November 16 to December 31, 1940. The average purchase price reported by retailers was $1.43 per box. The mark-up averaged $1.07 per box.

(*Bankhead-Jones Fund*)

The Supply and Distribution of New Hampshire Milk (Alan MacLeod and A. L. Erikson)

In 1938, the station issued a publication on the first phase of a trucking study conducted by Mr. MacLeod. Particular emphasis was laid upon the charges levied for the transportation of milk, these charges being analyzed in considerable detail in an attempt to determine not only their amount but the bases upon which they were set. Work on the second phase was completed in 1940, and a second publication dealing with the reorganization of trucking routes was issued.

It should be emphasized that the reductions in trucking costs outlined in the above-mentioned publications are potentially within the power of producers to bring about. Unlike some of the other costs of distribution which are incurred at stages in the distributive process far removed from the producer, the cost of milk trucking is usually

paid directly by the farmer in the form of a deduction from his check. The $300,000 a year now being paid by New Hampshire farmers for transportation of milk to country stations and city plants may be reduced by a lowering of charges on routes where they are above the competitive levels, and by a reorganization of the routes and milksheds. No attempts were made in the study to estimate the size of the possible reduction in trucking charges if truck rates were adjusted to competitive levels, but all evidence indicated that it would be substantial. The reorganization of routes as presented by Mr. MacLeod indicates that savings through this method might amount to from $30,000 to $35,000 a year, or about $39 to $45 a year for each farm.

A further phase of the New Hampshire study of the supply and distribution of milk was completed in 1940. This phase is concerned with price relationship on the supply side of certain New Hampshire markets. Prices were secured and analyzed for areas where milksheds overlap and two or more markets compete for the available milk. It was found that substantial variation in the prices paid for milk in such competing areas may exist for long periods and yet there may be very little shifting by farmers from one outlet to another. The reasons for this immobility of farmers are numerous and diverse. Ignorance of better prices, loyalty, and inability to get into better markets are among the chief reasons attributed to the stability of producers in such areas.

Work has begun on the distributive and consumer's side of the market. Factors affecting the amount of milk consumed by selected groups in Manchester have been studied, and the effects of price changes in some of the markets are being observed.

(*Bankhead-Jones Fund*)

AGRICULTURAL ENGINEERING

The Design of Small Potato Storages for Farm Use (W. T. Ackerman)

The data accumulated in 1939 and 1940 from the tests of conditioning in five potato storages have been analyzed to determine methods of controlling (1) temperature, humidity, and condensation; (2) rapid decay or deterioration of structural parts of the storages; and (3) possible improvements in heat-generating equipment and use of insulation. Weaknesses in the five storages which were observed during 1939 have been changed, and observations are being made under the improved conditions. Heat requirements have, in particular, been cut down on some of these storages. It is planned that both costs and advantages of building various types of improved storages will be analyzed.

(*Purnell Fund*)

Dehydration and Processing of Medicinal Herbs (W. T. Ackerman)

Investigations and experimental work in the dehydration and processing of medicinal herbs began in July, 1940. A drier of the

tray type was constructed, with a capacity of 200 pounds of green material. The tests conducted were aimed at drying a maximum amount of material in a minimum length of time, conforming, at the same time, to the requirements of the United States Pharmacopoeia.

Temperatures in two general ranges, 80° to 140° F and above 140° F, were used, and various humidity levels between 30 and 70 per cent were tested. Forced air draft was accomplished by the use of fans, air valves being used to control the volume and velocity of the air currents. The time required to dry to the United States Pharmacopoeia specifications varied from 30 to 60 hours for the 200 pounds of green material.

(*Bankhead-Jones Offset Fund*)

AGRONOMY

A Study of Pasture Species Under New Hampshire Conditions (F. S. Prince, P. T. Blood, and L. J. Higgins)

Work was continued during the year on the selection and breeding of timothy, red clover, and strains of white clover (Trefolium repens). Seeds and cuttings of these species were gathered from old pastures which had been grazed for long periods, and the plants were propagated in the greenhouse and nursery. Some of these selections have been continued for several years in an attempt to develop better strains for New Hampshire conditions. It is known that some of the selections of red clover have a basic triennial habit, and it is one of the objects of the experiment to cross these selected red clover plants in an effort to develop a strong triennial or perennial strain. A further aim of the project is to develop a Ladino-wild white clover cross which possesses the height of the Ladino clover and the hardiness and leafiness of the wild white clover. Work is also progressing on the development of a late hay as well as a pasture strain of timothy.

Trial seedings of a great many species and strains of legumes and grasses suited to pasturing were made in 1939 and 1940, the trials consisting of simple mixtures, i.e. one grass and one legume, and including both domestic and foreign strains. Counts at the close of the 1940 season showed that Ladino clover, to a greater extent than the other legumes, gained dominance over all the grasses with which it was seeded (smooth brome, orchard grass, tall fescue, Swedish perennial rye grass, and various strains of timothy). The grasses which appeared most aggressive are orchard grass, Swedish perennial rye grass, and Reed canary grass.

(*Bankhead-Jones Fund*)

An Experiment With Legumes on Neglected Hay Lands (F. S. Prince, P. T. Blood, T. G. Phillips, G. P. Percival, and P. N. Scripture)

This is the second year the Whenal alfalfa plots at Greenland have been harvested under the scheme of fertilizing in which annual fertilization is being compared with three times the annual amount

applied just before the time of seeding. The annual units consisted of 300 pounds of 20 per cent superphosphate and 100 pounds of 60 per cent muriate of potash.

In contrast to the adverse 1939 hay season, 1940 was one of the most favorable alfalfa years since 1925. Yield variations on the different types of fertilized plots tended to level off, perhaps because of the ideal weather and because in another year all the plots will have had exactly the same amounts of plant food over the three-year period. While it is still early to draw conclusions from the experiment, the combined data for the two years indicate that it is better to apply heavy applications of plant food at seeding time rather than spreading smaller applications annually. By the end of 1941, when all the plots will have received the same amount of fertilizer, more definite conclusions will be possible.

The plots on the Ireland farm, Greenland, were seeded to pure alfalfa in 1935, each plot receiving an annual top-dressing in accordance with the fertilizing plan of the experiment. During the five-year period grass has been replacing the alfalfa at an increasing rate, until in 1940 the first cutting was probably one-half grass. It is significant that the plots most heavily treated with fertilizers had more alfalfa and less grass than the lightly treated plots.

A combination of the five-year data shows that yields were increased by additional increments of fertilizer up to the maximum amount of 1500 pounds of 4-16-16 fertilizer per acre. However, the increases were not sufficiently great to warrant the application of so large an amount of fertilizer each year. The data further show that nitrogen is necessary for good hay yields. An average increase of 904 pounds of hay per acre was obtained from plots treated with 750 pounds of 4-16-16 fertilizer per acre, as compared with the same quantity of 0-16-16 fertilizer. However, yields were increased only 262 pounds by increasing the nitrogen content from 750 pounds of 4-16-16 fertilizer to 750 pounds of 8-16-16 fertilizer.

Comparisons for phosphoric acid and potash show that the difference between 375 pounds of an 8-16-16 and 750 pounds of a 4-16-16 fertilizer (equal amounts of nitrogen and double amounts of phosphoric acid and potash) resulted in an average increase of 1134 pounds of hay, the additional hay being worth (at current prices) about twice the additional cost of the fertilizer. However, increasing the fertilizer application from 750 pounds of an 8-16-16 combination to a 1500 pound application of 4-16-16 fertilizer (equal nitrogen) resulted in an increase in hay worth only about one-third the cost of the additional fertilizer.

(*Purnell Fund*)

Potatoes in a Dairy Farm Rotation (F. S. Prince, P. T. Blood, T. G. Phillips, G. P. Percival, P. N. Scripture)

This experiment, conducted at Colebrook, New Hampshire, is laid out to test different plant food levels, different fertilizer ratios, and different methods of fertilizer application, as well as different rotation systems. Although the work has been carried on for 12 years,

the project was shifted to a different farm in 1940 and the design of the experiment changed somewhat. The yield variations on plots treated in different ways in 1940 were slight, especially on those where only the fertilizer formula was varied. This may be partly accounted for by a relatively unfavorable growing season in the area. It is perhaps of some significance that yields were highest in all cases where the fertilizer was drilled, while yields were lowest for those when the fertilizer was applied broadcast. However, inasmuch as this is the first year of the experiment in its present form, not a great deal of weight can be placed upon the results.

(*Purnell Fund*)

A Fertilizer Experiment with Dairy Farm Crops in the Connecticut Valley (F. S. Prince, P. T. Blood, G. P. Percival, P. N. Scripture)

The plots upon which this experiment has been conducted are located on the Livingston farm at Claremont, New Hampshire. Since the beginning of the project in 1930, no changes have been made in the fertilizer treatment, although a variety of crops have been grown on the plots.

The fields were seeded to hay in 1937, and the 1938 crop showed a fairly uniform stand of clover. However, by 1939 the clover had disappeared from all plots except those which received potash. The clover persisted on the potash-treated plots in 1940, making up about 40 per cent of the stand. Grass also grew better on the latter plots, these plots being the only ones on which a second cutting was possible in 1940.

The yields of hay obtained in 1940 and the average yields for the past three years indicate that neither lime nor phosphorus alone stimulated hay yields, whereas potash alone in 1940 showed a gain of 1862 pounds over the check plots. Phosphorus used in conjunction with potash gave much greater gains than could be attributed to potash alone. The same thing appears to be true when lime is combined with potash, as is shown in the data presented below.

LIVINGSTON FARM HAY YIELDS, 1940 AND 1938-40

	Pounds of Cured Hay Per Acre	
Treatment	1940 Yield	3-Year Average Yield
Check	2048	2682
Lime	2055	2611
P	1928	2646
K	3910	4527
Lime-K	4448	4911
PK	6185	7496
NPK	7138	8016
LNPK	7300	8117

(*Purnell Fund*)

A Dairy Farm Rotation Experiment in Southern New Hampshire with Sweet Corn as a Cash Crop (F. S. Prince and P. T. Blood)

During 1939 the dairy farm rotation experiment conducted at Chichester was revised to include sweet corn in the rotation instead of potatoes. The field is the same as that on which a three-year rotation of potatoes, oats, and clover had been grown during the previous six years. Sweet corn was continued again in 1940 with various fertilizer treatments.

Because the 1939 season was so dry that yields of corn were cut severely, the data obtained that year were not considered of great value. Results of the 1940 crop indicate that a planter application of 4-16-4 fertilizer, in addition to some manure and super-phosphate spread broadcast, will prove the most satisfactory treatment for sweet corn on farms where manure is available. If manure is not available, a high phosphorus content fertilizer, such as 4-16-4, in amounts up to at least 1000 pounds per acre seems justified on the better soils. This may be supplemented with nitrate of potash at the last cultivation.

(*Purnell Fund*)

A Survey of the Soils of New Hampshire (F. S. Prince, W. H. Coates, R. Feuer, G. P. Percival, and P. N. Scripture)

The survey of soils begun in 1937 in cooperation with the Soil Conservation Service and the Division of Soils has continued. During 1940 work was finished in Hillsborough and Strafford counties.

Beginning with Strafford county, the plan of the work was changed. In this county soils, slope erosion, and land cover were mapped, giving a more comprehensive picture than for other counties. This procedure, however, necessitated plane-table work in each field, and the time involved for a county has been increased considrably.

(*Purnell Fund*)

Devising Methods for Controlling Erosion on New Hampshire Potato Fields (W. H. Lyford)

This project carries on the work formerly reported under the title "The determination of run-off and erosion from representative groups of New Hampshire upland soils." The study is being made in conjunction with the Soil Conservation service.

In accordance with the plan of the experiment, seven run-off plots, all of which had been in heavy sod, were established in the spring of 1940 at Northwood Ridge, New Hampshire. Potatoes were grown on the contour on six of the plots, and the seventh was left in grass. During the season, soil and water losses, together with certain climatic data, were recorded at frequent intervals.

The data collected indicate that erosion previous to freezing was practically negligible. Evidently, the run-off erosion was controlled by contouring and by the use of a soil which had been in sod the previous season. Soil on which sod has been recently broken up

tends to absorb water rapidly. After the soil was frozen, run-off of water was greatly accelerated, but the loss of soil was not severe. Tests run during the winter of 1939-40 show that loss of soil on cultivated fields is related to the depth of frost, the length of time the frost is in the ground and the manner in which the soil thaws. The most critical time of the year from the standpoint of soil loss is in the spring when the soil is thawing from the top and slightly from the bottom. Under these conditions the upper soil is essentially in a state of supersaturation and is in ideal condition to be carried away with the run-off.

Winter rye sown not later than October 1 provides a good protection against early spring erosion on potato land. However, most potatoes are harvested after October 1, and it is questionable if late rye attains enough growth in the average season to protect the soil against early spring erosion. Further tests on rye covering will be conducted next year.

(*Purnell Fund*)

An Experiment in Top-Dressing Old Pasture Lands with Lime and Fertilizer (F. S. Prince, P. T. Blood, G. P. Percival, and P. N. Scripture)

This project was continued in Stratham and Claremont, with minor changes only. One of the variations involved the delaying of the nitrogen application on the complete fertilizer plots until June 15. On another plot, one-half of the nitrogen was applied at the usual date, about May 1, while the remainder was applied June 15. The object of the changes was to determine whether the period of nitrogen stimulation can be extended into the summer.

All of the data accumulated up to the close of the 1939 season were published in station bulletin 320, "Pasture Top-Dressing in New Hampshire," April, 1940. Similar data obtained for the 1940 season show little change.

(*Purnell Fund*)

Seed Inspection (B. G. Sanborn)

The regular seed inspection work for the State Department of Agriculture was continued. During the year 704 samples of seed were handled by the laboratory. Of this number, 408 were collected by the state inspector and are reported in station bulletin 328. The remaining 296 samples were sent in by private individuals.

(*Miscellaneous Income*)

Variety Tests (L. J. Higgins)

The testing of various strains of silage corn, alfalfa, and soybeans has been continued. In 1940, twenty-two varieties of corn were planted in replicated, randomized blocks and the number of pounds of dry matter per acre was recorded for each variety at harvest time. Although the data for 1940 show that some of the newer hybrids are promising, the experiment will have to be carried through several more seasons before definite conclusions can be drawn.

The alfalfa tests have been carried on since 1937 with 35 strains and numbered varieties of alfalfa seed, together with seven standard varieties for checks. The data collected thus far show that of the standard varieties Grimm, Ladak, Baltic, and Hardistan have stood up very well. Several of the other strains have shown good results, some surpassing the standard varieties in hardiness and yield. The data collected have been forwarded to the United States Department of Agriculture and will be combined with data taken from all alfalfa nurseries in the country.

The work on soybean testing was completed in 1940, and a station circular will be published early in 1941.

(*Bankhead-Jones Offset Fund*)

ANIMAL HUSBANDRY

Nutritional Studies with Dairy Cattle (E. G. Ritzman and N. F. Colovos)

The studies on the nutritional physiology of dairy cattle have been continued. Between October, 1939 and May, 1940, twenty basal metabolism experiments and twelve complete balances of ingo-outgo of matter and energy were carried out on four Holstein heifers, the animals being four months of age at the beginning of the experimental period. During the period the animals were fed 7.23 pounds of digestible nutrients daily, of which only 0.623 pounds was digestible protein. On this ration the average daily gain in weight was two pounds per head, or about 33 per cent higher than the generally accepted standard of 1.5 pounds per day for the first year.

The basal metabolism of the 4-months old animals at the beginning of the experiments was 20,470 calories per 500 kg weight. Seven months later this had fallen to 12,015 calories, demonstrating the extraordinary tissue stimulus that characterizes the rapid growth at this early stage of life.

Observations of the effect of visual light on basal metabolism and other physiological activities have been continued. One pair of the four animals was kept in darkened stalls for the seven months, while the other pair was exposed to auxilliary illumination in addition to natural daylight. Data on blood constituents showed no difference between the two pairs, nor was there an appreciable difference in the basal metabolism.

(*Purnell Fund*)

Studies on the Energy Expended by a Horse at Work (E. G. Ritzman)

A series of experiments have been carried out this year to study the effects of drawing loads of varying resistance and at different speeds on the energy expended by a horse performing the work. The same apparatus which has been described in previous reports was

used in making the tests. In the table below some of the results of the experiment have been recorded. It will be noted that the energy expended increased rapidly as the load increased.

Pull	Speed of pull	Elapsed time	Distance	Energy expended per hour	
				Total with load	Total without load
(lbs.)	(min. per mile)	(min.)	(yds.)	(cals.)	(cals.)
160	19	10	913	5040	2740
195	20	5	435	5435	2145
195	20	10	884	5450	2145
225	18	5	478	7630	2740
235	21	5	417	7380	2145
250	18	5	478	9000	2740

(*Purnell Fund*)

Sheep Breeding (E. G. Ritzman and A. D. Littlehale)

The research on applied genetics with sheep is now in its final stage of progress. During the last four years a gradual shift has been made to standardize the flock on a Suffolk type basis, but possessing four functional nipples and also a high twin-bearing tendency. That the yield of milk from four-nipple ewes has been increased is demonstrated in part by the rate of growth of lambs from these ewes. Daily gains of twins from four-nipple ewes exceeded the gains of twins from two-nipple ewes by 47 per cent during the first 42 days of growth, while the corresponding figure for single lambs was 36 per cent.

A factor theory illustrating the probable method of inheritance of this trait was proposed. This appears to check closely enough with the actual results obtained by breeding tests to offer a prospect for breed improvement in this particular functional trait on the basis of genetic principles.

In terms of practical results in the development of the twinning tendency, some progress is demonstrated by a comparison of the lamb production in the original foundation stock, which was 135 per cent, with that of the 1940 flock, which (even including first lamb ewes) was 161 per cent, and 185 per cent for a selected group of ewes.

(*Adams Fund*)

Studies on Bovine Mastitis (L. W. Slanetz)

Studies on the classification of mastitis streptococci and staphylococci and on the effectiveness of segregation for the control of mastitis were continued. Particular attention was given to the toxins produced by staphylococci associated with mastitis infection, and to the isolation and determination of characteristics of bacteriophages used against these organisms.

A highly buffered glucose beef-infusion agar medium was found to be essential for the production of potent staphylococcus toxins. The use of 1.0 per cent agar, incubation in an atmosphere containing 20 to 30 per cent carbon dioxide and incubation of 37°C for 48 hours

were found to favor maximum toxin production. Alpha toxin was found to be inactive by heating at 80°C for one-half hour. Beta toxin resisted heating at 80°C for 30 minutes and, in some cases, was not inactivated at a temperature of 100°C for 30 minutes. A number of strains of staphylococci from cases of staphylococcal mastitis produced enterotoxin.

Methods were developed for the isolation of staphylococcus bacteriophage from milk. A pour plate technique using semi-solid agar (0.5 to 0.8 per cent) was devised, which facilitated counting and morphological study of phage plaques. Milk samples from a herd of 20 cows showing evidence of staphylococcus mastitis were examined and staphylococcus phages were isolated from 7 of the 20 cows. The bovine phages isolated were similar to phages from human sources in most respects. All attempts to show specificity of lysis failed completely; phages from milk lysed staphylococci of both bovine and human origin and phages from human sources did likewise. There was no correlation between susceptibility to lysis and biochemical or toxin-producing characteristics.

(*Purnell Fund*)

BOTANY

Effects of Soil Moisture and Fertilizer Placement on the Vitality of the Potato Seed Piece (Stuart Dunn)

Seed pieces from the distal end of potato tubers were grown in sandy loam at two temperatures (20.3°C and 13.8°C), and at three soil moisture contents (50, 60, and 70 per cent of saturation). Fertilizer treatment for each consisted of (a) no fertilizer, (b) 21 grams per plant (750 lbs. per acre) spread in a circular band 21 inches wide and ½-inch distant from the seed piece, and (c) 14 grams of fertilizer spread as in (b) above.

Results of the experimental work show that rate of emergence from soil was not particularly influenced by the treatments. Rate of growth, however, was greater for the fertilized plants, and the response of plants to fertilizer was more pronounced in the cold than in the warm temperature.

A station circular on this project, to be published early in 1941, will summarize the results for the five years of experimentation.

(*Adams Fund*)

A Study of the Causes of Injury by Lime-Sulphur Sprays (O. Butler)

In the experiments performed during the year, a study was made of the rate of recovery of the bean from lime-sulphur spray injury. The plants were sprayed three times at 7-day intervals and harvested 7 days, 21 days, and 28 days after the last treatment. While the results secured show some variation, the plants have always recovered following spraying. Several lots of plants were also sprayed with ½ per cent and 1 per cent flotation sulphur, the former being found more injurious than the latter. In some trials, the flotation sulphur sprays were found to be more injurious than the lime-sulphur sprays, while in other instances they were less injurious.

(*Adams Fund*)

The Effects of Mulching on the Development of Bitter-Pit in Apples (O. Butler)

The mulched trees produced fewer apples over 2½ inches than the non-mulched trees, and the total yield of the former was only 92 per cent that of the latter. The tabulation below indicates the relationship between mulching and bitter-pit, as recorded in this study.

PER CENT OF BITTER-PIT

Size of apples	At harvest		After 83 days storage	
	Mulched	Non-mulched	Mulched	Non-mulched
Over 2½ inches	5.05	3.72	29.2	10.4
Under 2½ inches	1.24	1.03		

(*Purnell Fund*)

Effects of Place on Mosaic and Leaf-Roll of the Potato Plant (O. Butler)

A number of cultures were set up in a fertile loam and treated as follows: (1) fertilized with dry cow dung and bone meal; (2) cow dung, bone meal, and acid phosphate; (3) 14 grams 8-16-16 commercial fertilizer per pot; (4) same as (3) plus acid phosphate; (5) 21 grams 8-16-16 fertilizer per pot; (6) same as (5) plus acid phosphate; (7) acid phosphate alone; and (8) no treatment. Cultures were also grown in sand with 8-16-16 fertilizer added.

Masking of mosaic was more complete in the commercial fertilizer cultures than in the non-fertilized series, or in the series treated with cow dung and bone meal. The addition of acid phosphate, or its use alone, produced no noticeable effects on the masking of symptoms. No relation was found between rate of growth of plants and masking of symptoms.

(*Purnell Fund*)

Relative Resistance of Peony Varieties to Blight and Control of the Malady (O. Butler)

In setting out the plot for the study of peony blights and methods of control, varieties have been chosen which, according to Winter's list, show different degrees of susceptibility. The moderately resistant varieties are planted in juxtaposition to the susceptible variety. Examination of the plants during the season showed that peony blight was present throughout the plot, though irregularly distributed.

Soil treatments for the control of peony blight were begun during the year. No conclusions are yet warranted.

(*Hatch Fund*)

Spraying for Apple Scab (O. Butler and Stuart Dunn)

During 1940 experiments were continued with flotation sulphur which was used at the rate of 16 pounds of the paste per 100 gallons of water, for the purpose of securing additional data on the control obtained when 3- and 2-cover sprays are used. The trees sprayed with

3 covers produced 8.08 per cent scabby apples, and those sprayed with 2 covers, 9.24 per cent.

Apples showing scab spots ranging in size from 1.105 mm. to 8.930 mm. were placed in storage at 4°C and were examined at the end of 92 days. The fruiting area in such small scab spots is always smaller than the infected area. Growth in storage consists in the enlargement of the fruiting area, not as a general rule of the infested area as a whole. The diameter of the fruiting area increased 41.05 per cent in size during the period of storage, but the diameter of the visibly infected area increased only 13.4 per cent.

Elgetol, a proprietary coal-tar dye, is also being used in an effort to control apple scab. The Elgetol is made into a spray and applied to the dead leaves on the ground in the orchard. This procedure appears to have some merit, but further experimentation must be done before definite conclusions are warranted.

(*Hatch Fund*)

Seed Certification (Stuart Dunn)

Forty-seven and three-eighths acres of Green Mountain potatoes were entered for certification and the entire acreage passed. Five and one-fourth acres of Chippewas and one-half acre of Irish Cobblers were entered and passed. Besides these, there were five and one-half acres of Houmas and other newer varieties entered and passed, making a total of 58⅝ acres.

(*Miscellaneous Income*)

ENTOMOLOGY

Penetration of Ovicides (W. C. O'Kane and J. G. Conklin)

The investigations in 1940 have been directed toward determining the ovicidal properties of various mineral oils, with special reference directed toward the relationship of viscocity to penetration and to ovicidal action. To facilitate this phase of the work, a glass device was constructed by the experimenters to atomize the oils. The atomizer was placed in the top of a bell jar and the spray directed downward for definite time intervals onto exposed insect eggs.

Eggs of the bean weevil (Acanthoscelides obtectus) were used in much of the work, supplemented with eggs of the Mexican bean beetle (Epilachna varivestis) and the confused flour beetle (Tribolium confusum). Five mineral oils were used, representing viscosities of 50 and 100 Saybolt, and sulfonation values of 75 and 95.

The results available to date are not conclusive. Further experimentation will be required before relationships can be clearly established.

(*Adams Fund*)

Penetration of Contact Insecticides (W. C. O'Kane, J. G. Conklin, L. C. Glover, and R. L. Blickle)

In the first half of 1940, investigations were continued to determine penetration of various liquids through the integument of an

insect. For these experiments, the investigators developed an apparatus consisting of multiple units in a constant temperature and constant humidity cabinet.

It was found that methyl alcohol exhibits a more rapid and extensive penetration than any of the other alcohols in the series used. A low boiling petroleum derivative gave a more rapid and extensive penetration than a fraction somewhat higher in boiling range. It seems possible that the ability of a liquid to dissolve the epicuticle of an insect, which is of a waxy nature, may influence the rate and amount of penetration through the integument. Interesting speculations also revolve around the question of size of molecule. The detailed results of these investigations were published in Technical Bulletin 74, "Penetration of Certain Liquids Through the Pronotum of the American Roach," No. XIV of the series "Studies of Contact Insecticides."

The latter half of 1940 was devoted to the development of a device (insect toximeter) for securing uniform application of liquids to all surfaces of test insects. The "insect toximeter" utilizes a turntable of controlled variable speeds, on which is mounted a device for holding a series of insects, each in a similar but separate position. The spray materials are delivered from two air brushes mounted in such a way that the two columns of mist meet at the turn-table and thereby give a uniform coating to all the insects in the experiment. The entire apparatus is mounted within a housing which prevents stray air currents or eddies. An exhaust fan removes the spray mist from the housing at the close of each experiment.

Utilizing this apparatus, an extensive series of studies are underway. They are designed to establish the relationship between variations in concentration of a given toxicant and variation in the number of seconds during which the toxicant is applied. They are also designed to establish the median lethal dose of materials which can serve as standards, including c.p. rotenone, nicotine, and the pyrethrins derived from pyrethrum flowers.

(*Purnell Fund*)

FORESTRY

Plantation Studies (C. L. Stevens)

The objective of this study is to determine what species of trees, both native and introduced, are best adapted to artificial reforestation in New Hampshire. Seedlings are raised in the nursey and set out on college-owned land. At intervals the plantations are visited, examined, and measured. The measurements of older plantations have been continued, and are now nearly complete.

Measurements of recent plantations of white and red pine show an average survival of 91 per cent in the 1938 area, and 96.5 per cent in the 1939 area. Small plots of exotic species planted in the arboretum in 1939 have not shown satisfactory results. Conifers average 60 per cent survival and hardwoods 84 per cent.

In the fall of 1940 approximately 3 acres of land were seeded

to butternut and black walnut. Shagbark hickory will be planted in 1941. This is the first attempt, under this project, at direct seeding, although this was a part of the plan as originally set up in 1912.

(Bankhead-Jones Offset Fund)

A Study of White Pine Stands (C. L. Stevens and L. C. Swain)

Stands of white pine in the northern part of the state have been examined in an attempt to locate a strain of trees having side branches of small diameter. This work is to continue, and seed from selected stands will be collected during the next good seed year. These seeds will be tried out in the nursery and plantations to see if this type of crown can be propagated.

The sample plots of white pine lost in the hurricane of 1938 have not been replaced, but it is expected that a complete series will be obtained in the near future.

(Bankhead-Jones Offset and Hatch Funds)

Spruce Reproduction Studies (C. L. Stevens)

In 1935 plots of spruce were established in a partial cutting and a clear cut area, and subjected to four methods of treatment as follows:

Plot 1. All brush and litter were removed, leaving the mineral soils completely exposed.

Plot 2. All brush was removed and the litter raked off small spots, two feet square.

Plot 3. All brush was removed and the soil scarified.

Plot 4. The brush was removed, the soil scarified, and the brush replaced.

In 1940 the area was visited and a tally made of all growing species on the experimental and check plots. The results of the tally give no indications that any of the treatments produced a satisfactory increase in the amount of spruce reproduction. There is a possibility that the seed supply has not been adequate during these five years, and for this reason it seems advisable to continue the work for a longer period before drawing any conclusions.

(Bankhead-Jones Offset Fund)

Fence Post Durability (C. L. Stevens)

The original data on this project, which was begun in 1929, were lost in a fire in 1937, and some of the posts have been moved to new locations. In 1940 only 60 of the original posts were located, 49 of which appeared to have been treated and 11 apparently untreated. It was impossible to determine the type of treatment of these posts, but all which had been treated appeared to be sound and in good condition. Eight of the untreated posts had rotted off and were lying on the ground; three were still in use but the posts underground had rotted very badly.

(Bankhead-Jones Offset Fund)

DAIRY HUSBANDRY

A Study of Dry Feed Systems of Raising Dairy Calves (K. S. Morrow)

This project has been set up to study the possibilities of weaning dairy calves from whole milk at an early age and then depending upon a dry calf starter and hay until the animals are six months old, at which age they are normally put on a standard heifer ration. In 1939, the data collected on four Guernsey calves, weaned at an average age of 44 days, showed that the calves were above normal in weight and height at six months of age. During 1940 four Jersey calves, weaned at an average age of 61 days, were placed on a similar ration to that used the previous year. While the Jerseys have not yet reached six months of age, the results to date indicate that the calves are approximately normal in weight and height.

The rations used in this experiment consisted of the following mixture: 400 pounds ground yellow corn, 300 pounds wheat bran, 200 pounds ground oats, 100 pounds linseed oilmeal, 100 pounds cottonseed meal, 12 pounds steamed bone meal, 12 pounds salt, .25 per cent (3.7 lbs.) cod-liver oil concentrate, and 25 per cent skim-milk powder. Mixed clover and timothy hay supplemented the dry calf starter.

(Bankhead-Jones Fund)

A Study of the Relation of the Conformation and Anatomy of the Dairy Cow to Her Milk and Butterfat Producing Capacity (K. S. Morrow)

Ante- and post-mortem data have been received on three cows during the year, making a total of sixteen cows which have been slaughtered in connection with this project. The information on these animals has been tabulated and forwarded to Washington, D. C., for inclusion with similar data from other cooperating stations.

No attempt has been made to analyze individual differences in the data, although interesting anatomical variations are observed as the data accumulate.

(Bankhead-Jones Offset Fund)

Variability in Milk Solids-Not-Fat (H. C. Moore and K. S. Morrow)

Using the method approved by the United States Department of Agriculture in proving bulls for milk production, the results of work on this project indicate that the three factors—milk production, butterfat content, and percentage solids-not-fat—may be inherited separately. A given sire may produce significant changes in one of these factors without any correlated effect on the others.

The tabulation below shows the degree of variation in the three factors for daughters of particular sires as compared with the dams of these same daughters.

VARIATIONS IN MILK SOLIDS-NOT-FATS PRODUCED BY DAUGHTERS OF ONE SIRE

Increase or decrease in performance of daughters compared with dams

Sire and breed		No. of daughters	Aver. difference in milk products	Aver. difference in butter-fat test	Aver. difference in percentage solid-not-fat
I	Hol.	6	−|− 68	— 0.21%	−|− 0.16
B	Hol.	16	−|− 242	−|− 0.24	−|− 0.28
B*	Hol.	8*	−|− 750	−|− 0.31	−|− 0.32
E	Hol.	6	−|− 428	−|− 0.06	— 0.13
M	Jer.	11	−|− 938	— 0.18	— 0.04
L	Jer.	7	— 1118	−|− 0.34	−|− 0.15

**Dams all sired by Bull I*

During the summer of 1940 work was started on a study of the chemical angle of the solids-not-fat, using the milk from 24 cows in the university herd. This work consists of making complete monthly analyses for fat, solids-not-fat, casein, albumen, total protein, sugar, and ash. While considerably more variation has been found in some of these constituents than was expected, the work has not proceeded far enough for conclusions to be made.

(*Purnell Fund*)

The Efficiency of Dairy Herd Management Practices as Revealed by Analysis of Permanent Records of D. H. I. A. HERDS IN New Hampshire (K. S. Morrow)

Data on this project have been recorded on approximately 3,000 animals. No summaries have been made to date, as it has been necessary to do considerable tabulation in converting production credits to a common mature basis. Detailed analysis will be attempted during 1941.

(*Purnell Fund*)

Normal Growth of Dairy Heifers (K. S. Morrow)

All dairy calves born in the university herd are weighed at weekly intervals until six months of age, and at monthly intervals from that age to 12 months. Cumulative data of this sort will serve as an index of normal growth of calves and will be valuable in checking results obtained for calves on experimental diets.

(*Miscellaneous Income*)

Raising Dairy Replacements (K. S. Morrow)

During the past year a study of methods of raising dairy replacements on New Hampshire farms was begun in cooperation with the county agricultural agents and the agricultural economics department. Forms for recording growth and feed data were prepared and distributed to dairymen who indicated a desire to participate in the study.

Data for the first fifty calves reported show a range of gains in

weight from .61 to 2.01 pounds a day, while feed costs for raising the calves to six months of age ranged from a low of $12.00 to a high of $56. The fifty calves were divided into three groups, according to the feed cost per pound of gain. In the tabulation below averages are presented for each group.

		Whole milk		Skimmilk or skim powder				
Group	No. of Calves	Days fed	Lbs.	Days fed	Lbs.	Lbs. grain	Ave. gain in wt. (lbs.)	Feed costs per 1 lb. gain in wt.
I	13	83	767	118	1603	330	304	$.094
II	15	61	515	116	1712	274	246	.112
III	22	61	519	106	1093	225	189	.136

(*Purnell and Hatch Funds*)

HORTICULTURE

Fruit Bud Formation (A. F. Yeager)

One per cent Elgetol was used on half trees of several apple varieties as a blossom removal spray. It was effective in completely removing blossoms and leaves. Many of the fruit spurs failed to recover, but the foliage in general was replaced satisfactorily.

(*Adams Fund*)

Plant Breeding Studies (A. F. Yeager and J. R. Hepler)

Considerable tomato breeding material was grown and studied during the year. A cross between the common tomato (L. esculentum) and Peruvian tomato (L. peruvianum) was carried through three generations of selfed material and two generations back-crossed to standard varieties. Partial recovery in size and quality was obtained, but the extent to which the selections are disease resistant remains to be seen.

Two generations from crosses between ordinary muskmelon and a perfect flowered Asiatic muskmelon (U. S. D. A.—236B) were grown during the year. Some early selections were made from the field which carried perfect flowers. Another cross from which it was hoped to obtain high quality, early, disease-resistant muskmelons was also carried through two generations, and selections apparently carrying the desired factors made.

About 100 single bean plant selections have been tested, the selections coming from the third generation of a cross between Gage and French Horticulture. Of this number, three strains were outstanding in the characteristics sought. They are fairly early, have good pod length, and the color of both the pod and shelled bean is particularly good.

In an effort to produce polyploids, colchicine in solution, in lanolin paste, and in agar was used on a large number of plants of various varieties. Apparently good results were obtained with several spe-

cies. It was found that treatment of seed produced favorable results more easily than did treatment of growing plants.

(*Purnell and Hatch Funds*)

Fertilizing Elements (L. P. Latimer and G. P. Percival)

The results of this experiment indicate that one-half pound to 20 pounds of borax applied to soils under Delicious and Golden Delicious apple trees in June did not cause any apparent injury to the fruit or foliage, and the apples from these trees kept as well in storage as those from trees receiving no borax. Weeds and grass were killed under trees receiving 10 to 20 pounds of borax, wild strawberry and yarrow being the weeds most sensitive to this treatment.

Greenhouse tests showed that cucumbers were slightly more tolerant of borax than were snap beans or strawberries. In acid soils, 15 pounds of borax per acre caused slight scorching of cucumber leaves. Larger amounts caused severe stunting and early death of plants. With less acid soils more borax could be applied without serious injury.

(*Adams Fund*)

Fruit and Vegetable Variety Tests (L. P. Latimer and J. R. Hepler)

Pathfinder was the only promising new strawberry variety in a test comparing Pathfinder, Jupiter, Town King, Joyce, and World's Wonder with Howard 17. Pathfinder yielded more fruit than Howard 17, while the other varieties were distinctly inferior in yield. The uniform size, round shape, and bright appearance of the fruit made baskets of Pathfinder more attractive.

Among the raspberry varieties tested, Indian Summer produced the best quality fruit, although in total production it rated no higher than Marcy or Taylor. Ruddy produced a large number of berries throughout a long period, but the berries are a little too small for commercial use.

The Melba apple continues to be the most promising new early variety, maturing its fruit six weeks before McIntosh and at the same time as Red Astrachan. It also keeps better in storage than Early McIntosh or Milton. Red Spy possesses an attractive red color but seems to have slightly softer flesh than Northern Spy.

Variety tests on a number of vegetables were run. The tests show that the only egg plant to produce a consistent crop was New Hampshire Hybrid. The most promising of the varieties of inbred corn tested are Early Spancross C4.13, Spancross 6.4 x C13, Cockscrow, Marcross 13.6 and Alphagold. Detailed results on these and other varieties are available in mimeograph form.

(*Hatch Fund*)

Apple Drop (L. P. Latimer)

Preliminary tests were made with hormone sprays on a number of apple varieties and on two peach varieties. Excellent results were

obtained with early varieties, but effects on late varieties are not definite.

(*Purnell Fund*)

Medicinal Herbs (J. R. Hepler)

The following herbs were planted in commercial quantities, largely to find out whether they could be grown and the methods of culture necessary to produce a good crop: digitalis, catnip, sage, summer savory, winter savory, pyrethrum, wormwood, peppermint, spearmint, horehound, sweet basil, and wormseed. All of these grew well. The digitalis, when transplanted in June, showed considerable variation in size and type of plant. Of the 5,000 plants set out, about 35 of the best were selected and taken into the greenhouse for further study.

(*Bankhead-Jones Offset Fund*)

Apple Storage (W. W. Smith)

Apples from the early ripening Milton variety and the later ripening Macoun variety were stored at 32°F. and 40°F. At the low temperature, the Macoun lost its characteristic flavor by Thanksgiving, although the fruit remained crisp until the following March. At the higher temperature, it kept its flavor and remained crisp into January. The Milton variety did not keep as long, showing breakdown in early January. However, the quality of both varieties was better when stored at the higher temperature.

Studies of the brown core disorders of McIntosh apples indicate that this diseased condition can be curtailed by cutting down the application of nitrogen fertilizer, picking the fruit when it is more mature, and storing at higher temperatures.

(*Purnell Fund*)

Winter Injury (W. W. Smith)

Experiments were started to study the effects of three nitrogen carriers on the acidity of the soil, concentration of nitrogen, and the carbohydrates in the phloem and xylem tissue of the tree trunk. A comparison of temperature changes at different levels from the outside of the trunk toward the center on the north and south sides of the trees is also being conducted. It is hoped that this data will give information concerning the prevalence of frost rings and other forms of winter injury on the north sides of trees. The tests are repeated on irrigated land to make a comparison between the high and low moisture soil.

(*Adams Fund*)

Rootstock Project (W. W. Smith)

A trial planting of 300 trees was set at Gilford in the spring of 1940, using four rootstocks; namely, Malling No. 4, French Crab, Virginia Crab, and Florence Crab. McIntosh, Cortland, and Northern Spy are to be top-worked on the Virginia and Florence Crab. The same varieties are budded with the French Crab and Malling No. 4 before setting. The experiment has been designed to test statistically

any differences which may later appear. In the nursery more combinations of ring grafts and interlock were made in order to have these trees ready to set in a trial orchard.

(*Bankhead-Jones Fund*)

Blueberry Improvement and Propagation (W. W. Smith)

Attempts were made during 1940 to root blueberry cuttings, using Maine peat, a peat which is very similar to that obtained in other sections of the United States. The results were largely negative. German peat, previously used in this work, appears to allow more aeration than native peat, and this characteristic apparently makes it more suitable for rooting blueberry cuttings.

Collections were made of high bush blueberries growing as far north as Conway. These will be used in future breeding programs to incorporate hardiness into the high bush blueberry plant.

(*Hatch Fund*)

Vegetable Culture (J. R. Hepler)

The Blue Hubbard variety of squash was planted on plots of high fertility. The land was covered with manure at the rate of 15 tons per acre, and in addition to the manure, various fertilizer treatments were used. There was no noticeable difference in the yields of the different plots. Five different insecticides were used on the squash to note their effects on the growth and yield of the plants, and on the control of insects. None of the insecticides controlled the squash bug, which had to be held in check by using the old-fashioned shingle method. There was comparatively little difference in yield among the plots receiving the different insecticide treatments.

Further experiments were made on the keeping qualities of squash in storage. Four treatments were used: waxing the squash with a commercial wax; dipping the squash in copper sulphate; use of formalin solution; and the check. Half of the squash were injured by cutting off the blossom before treatment, and all were stored at a temperature of 45° to 50°F. At the end of three months it was found that approximately 89½ per cent of the weight of the untreated and the copper sulphate-treated squash remained, while about 93 per cent of the weight of the other two treatments remained. Apparently, injuring the squash by cutting off the blossom end had little effect.

(*Hatch Fund*)

Poison Ivy Control (C. L. Calahan)

"Atlacide," a sodium chlorate weed killer, and ammonium sulfamate were applied in different concentrations throughout the growing season to vigorous poison ivy plants. Results of the 1940 season indicates that ammonium sulfamate is an effective ivy-killing agent and does not sterilize the soil, as do the sodium compounds. This chemical might prove valuable to destroy ivy growth around orchard trees and may liberate nitrogen enough upon decomposition to be of value to the trees.

(*Hatch Fund*)

Ornamentals (H. S. Clapp and W. D. Holley)

One hundred sixty-four ornamental woody plants, representing 131 species and varieties, are being studied to obtain hardy strains with low susceptibility to diseases.

Lilac breeding and selection are being conducted to develop types of superior quality for New England. The present collection consists of 171 plants, representing 108 hybrid types, and 22 species and varieties. As a result of treatment with colchicine, several seedlings are apparently tetraploids.

Data on the common house plants are also being gathered.

(*Bankhead-Jones and Hatch Funds*)

POULTRY

Protein Requirements of Chickens (R. C. Durgin, T. B. Charles, S. R. Shimer, and H. A. Davis)

This study of the protein requirements of chickens was begun in 1935. Two groups of birds were carried in batteries and laying cages for a period of 70 weeks each, while a third group in floor pens was checked for 70 weeks.

It was found that as the protein content of a ration increased from 15 to 19 per cent, a definite increase in body weight occurred in chicks fed this ration. No relationship was apparent between percentage of protein and total feed consumption, but a very definite correlation was found between total feed consumed and total body weight attained during the experimental period.

Chicks receiving the protein mixture and fish meal supplement were significantly heavier in weight at 12 weeks of age than were the chicks fed meat scrap or dried skim milk. Generally, the birds receiving the lower protein rations were the most efficient in feed utilization during the growing period. The groups receiving fish meal as the sole source of animal protein were found to have a higher average rate of production of eggs and produced a greater number of eggs per bird than other groups. They were also lowest in feed cost per dozen eggs produced, and earliest in sexual maturity. There appears to be no correlation between the protein content of the ration fed and the size of eggs, or the age at which the chickens laid their first eggs.

A record of the hatchability of the eggs from these groups was also kept, and gizzard erosion was studied in all the chicks that hatched. It was found that as the percentage of protein in the meat, fish and mixture groups was increased, the gizzard linings improved noticeably, showing less gizzard erosion. In the birds fed dried skim milk, an increase in the level of protein resulted in the gizzard condition becoming progressively worse.

(*Purnell Fund*)

Selective Breeding as a Control of Disease (R. C. Durgin, T. B. Charles, C. L. Martin, and C. A. Bottorff)

The post-mortem records maintained by the poultry department show that ruptured egg yolk is one of the major disease conditions responsible for adult mortality among chickens. Bacteriological analyses indicate that bacteria are not the primary cause of this condition. For this reason, the department has carried on selective breeding in order to determine to what extent the tendency toward a rupturd egg yolk condition is transmitted to progeny. Results to date indicate that there is high, positive correlation between low incidence of mortality from ruptured egg yolk in the family, and the incidence of this condition in the progeny of the surviving members of the same family.

During the spring of 1940, 554 chicks were hatched from 16 dams of the low mortality groups, and 671 from 22 dams of the high mortality groups. These chickens are now being observed in further investigation of the problem.

(*Purnell Fund*)

Poultry Litter Moisture (T. B. Charles, R. C. Durgin, and W. T. Ackerman)

Peat litter was put into each of three pens. In two pens, the litter was spaded and raked to allow it to dry more rapidly, while in the third pen the litter was untreated. The difference in the condition of the litter in the three pens appeared to have no effect on feed consumed, on eggs produced, or on the percentage production of eggs. Mortality was slightly lower in the pen where the litter received the best treatment, but the difference may not be statistically significant.

It was found that the litter could be maintained in a drier condition in those pens where drip guards were installed about the water fountains. Improving the drainage about the buildings was also of value.

(*Purnell Fund*)

Incidence of Gizzard Erosion (T. B. Charles, J. H. Gillespie, and C. L. Martin)

Fifty to seventy-five eggs were obtained from each of twenty-two poultry departments at the various state experiment stations in the United States. These eggs, together with 68 eggs from each of two college flocks of New Hampshires, were placed in one incubator and incubated under identical conditions. From these eggs, 715 chicks were hatched and examined for gizzard erosion. Out of the total number, only 13 males and 15 females showed a normal gizzard condition as examined by the naked eye. There appeared to be no significant difference between the gizzard conditions of different breeds, and apparently there is no relationship between sex and incidence of gizzard erosion.

Of particular importance is the fact that gizzard erosion is widespread. The chickens hatched from eggs of one locality of the Unit-

ed States were no more free of ulcerated gizzards than those hatched from eggs obtained from any other locality.

(*Purnell Fund*)

National Poultry Improvement Plan (R. C. Durgin and David Flagg)

Record of Performance. During the past year, 13 flocks, consisting of 7,576 chickens, were entered in the United States Record of Performance program. Of this number, 1873 birds, or 32 per cent, qualified for certificates. To meet the Record of Performance requirements for certificates, birds must lay a minimum of 200 standard-sized eggs in a laying year.

United States Approval and Certified Stage. This year 44,305 birds were banded and selected according to the requirements of the United States Approval Stage of the National Plan. Eighteen flocks were approved, as compared with eight flocks in 1939-40. Nine flocks met the requirements of the United States Certified Stage, as compared with two flocks last year.

(*Miscellaneous Income Fund*)

Poultry Autopsies

Autopsies were made on 2913 specimens, consisting chiefly of adult chickens, chicks, adult turkeys, and poults. Among the 1534 adult chickens examined, the most prominent diseases were blue comb, ruptured egg yolk, and traumatism. With chicks, the major diseased conditions were naval infection, chronic coccidiosis, ulcerated gizzard, and pneumonia. Blackhead and omphalitis were the principal diseases found among both the adult and the young turkeys, although cases of many other diseases were found.

(*Miscellaneous Income*)

Pullorum Testing

Among the 782,626 birds (chickens and turkeys) tested for pullorum, 336 reactors, all females, were segregated. The largest percentage infection was found among the White Plymouth Rocks, 0.264 per cent of which were reactors. The Barred Plymouth Rocks had 0.017 per cent infection, and the New Hampshire's, 0.045 per cent. The other breeds tested showed no reactors, and all turkeys tested were free of the disease.

(*Miscellaneous Income*)

Textile Research Project

Interest and cooperation in a textile research project conducted by home economics research workers continued through 1940, although not a large number of samples have been secured. To date, there have been 83 pieces of material sent to State College, Pennsylvania, for testing purposes.

The ultimate reason for making this study is to find (1) what performance can be expected of textile fabrics of different constructions and dyed with different dyes, and (2) what changes, if any, should be made in present methods of testing fabrics in the laboratory, so

that performance can be predicted from laboratory tests.

A report of the analysis of each fabric is sent to the owner who keeps a record of the amount of wear the garment receives, number of times it is cleaned, where it first shows signs of wear, etc.

When no longer considered wearable by its owner, the garment is sent to the laboratory for examination and comparison of the results of actual wear with the predictions made for it on laboratory tests. To date 17 garments have been sent to the laboratory.

The amount of $1.43 has been paid in 1940 for the pieces of material used for testing purposes.

(*Purnell Fund*)

670.5